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Role of Erosion in Shaping Point Bars

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A powerful metaphor in fluvial geomorphology has been that depositional features such as point bars (and other floodplain features) constitute the river's historical memory in the form of uniformly thick sedimentary deposits waiting for the geomorphologist to dissect and interpret the past. For the past three decades, along the channel of Powder River (Montana USA) we have documented (with annual cross-sectional surveys and pit trenches) the evolution of the shape of three point bars that were created when an extreme flood in 1978 cut new channels across the necks of two former meander bends and radically shifted the location of a third bend.

Subsequent erosion has substantially reshaped, at different time scales, the relic sediment deposits of varying age. At the weekly to monthly time scale (i.e. floods from snowmelt or floods from convective or cyclonic storms), the maximum scour depth was computed (by using a numerical model) at locations spaced 1 m apart across the entire point bar for a couple of the largest floods. The maximum predicted scour is about 0.22 m. At the annual time scale, repeated cross-section topographic surveys (25 during 32 years) indicate that net annual erosion at a single location can be as great as 0.5 m, and that the net erosion is greater than net deposition during 8, 16, and 32% of the years for the three point bars. On average, the median annual net erosion was 21, 36, and 51% of the net deposition. At the decadal time scale, an index of point bar preservation often referred to as completeness was defined for each cross section as the percentage of the initial deposit (older than 10 years) that was still remaining in 2011; computations indicate that 19, 41, and 36% of the initial deposits of sediment were eroded. Initial deposits were not uniform in thickness and often represented thicker pods of sediment connected by thin layers of sediment or even isolated pods at different elevations across the point bar in response to multiple floods during a water year. Erosion often was preferential and removed part or all of pods at lower elevations, and in time left what appears to be a random arrangement of sediment pods forming the point bar. Thus, we conclude that the erosional process is as important as the deposition process in shaping the final form of the point bar, and that point bars are not uniformly aggradational or transgressive deposits of sediment in which the age of the deposit increases monotonically downward at all locations across the point bar.